Engineering Calibrated Biometrics Systems

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Report Documentation Page

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Problem

- **Performance gap between technology tests and fielded systems**
  - Integration into exiting processes and systems (e.g., isolated watch list systems)
  - Environmental factors, quality, data interchange
  - Accounting for human behavior and operational controls (intent and tactical variances)
- **Systems level performance predictions are desired**
  - Bayesian models
    - Human intent and sensor performance
    - Alternate explanations
    - Prior probabilities
- **Systems level engineering method is desired**

  (assume security policy in effect)
  - Determine system boundaries
  - Define physical environment (e.g., room, facility, vicinity)
  - Sensor model development
  - Define assessment software, all {Sensor-Software-Application}-tuples
  - List infrastructure needs
  - Define collection, alerts, and reporting plans

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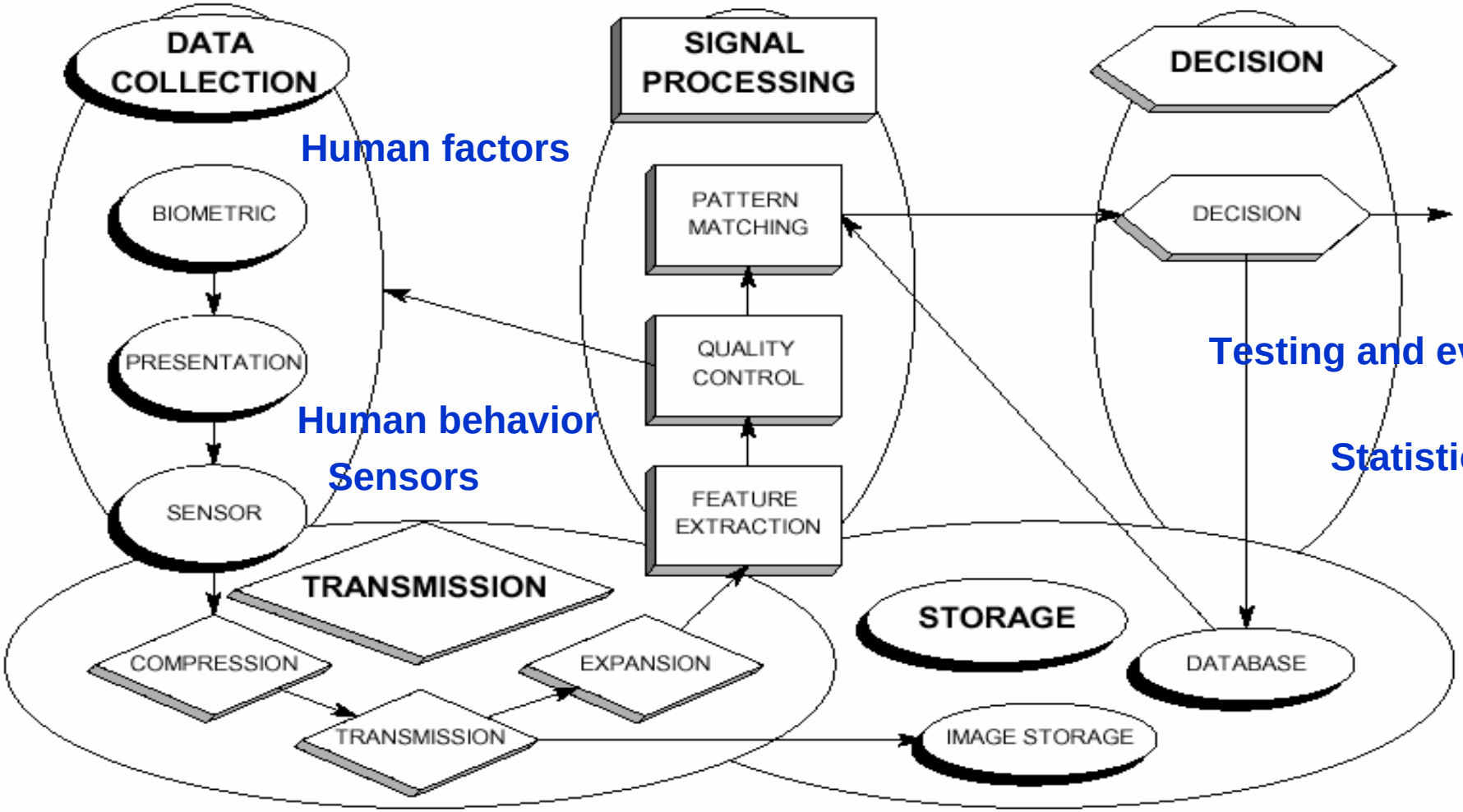
Background (systems)



Human factors

Human behavior

Sensors

Testing and evaluation

Statistics

Anthropometry

Physiology

Image processing

photorealistic rendering

3D graphics

Architecture

PKI/CAC/SSO

Policy, privacy, security, legal

System diagram from "*National Biometric Test Center Collected Works*" Dr. Wayman Aug 2000

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Objective

- **Overall: To explore scenarios for authentication, identification, and detection of furtive behavior using a predictive model in conjunction with an actual sensor environment**
  - **Understand the appropriate uses of biometrics per environment and mission**
  - **Identify integration and interoperability issues for data, scoring, decisions, alarm management, and reporting**
  - **Perform targeted studies into major performance factors that compromise system robustness**
- **Current Fiscal Year Objectives:**
  - **Biometrics laboratory**
  - **Systems taxonomy**
  - **Use synthetic 3D face models to augment and extend biometric test methodology (FERET)**

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Activities

Problem	Proposed Solution/Goal	MOIE progress toward goal	MOIE Products (*Tech Transfer*)
Realistic testing, reflecting real world variances and operational difference	Synthetic data generation	3 targeted FaceGen experiments (Papers, Demo)	Papers documenting approach and experimental results 2 papers released, 1 published (ACM), 3 in draft
System level performance predictions	Bayes nets for performance modeling	Developed nets for several lab & hypothetical systems, informal prediction testing	Paper articulating approach w/ Demo (*ITIC tradeoff study; CAASD, CEM requests to brief to DHS sponsors*.)
System level engineering method	System component representations that 'feed' performance model	Examined Sensor modeling UML and system taxonomy	Paper articulating framework

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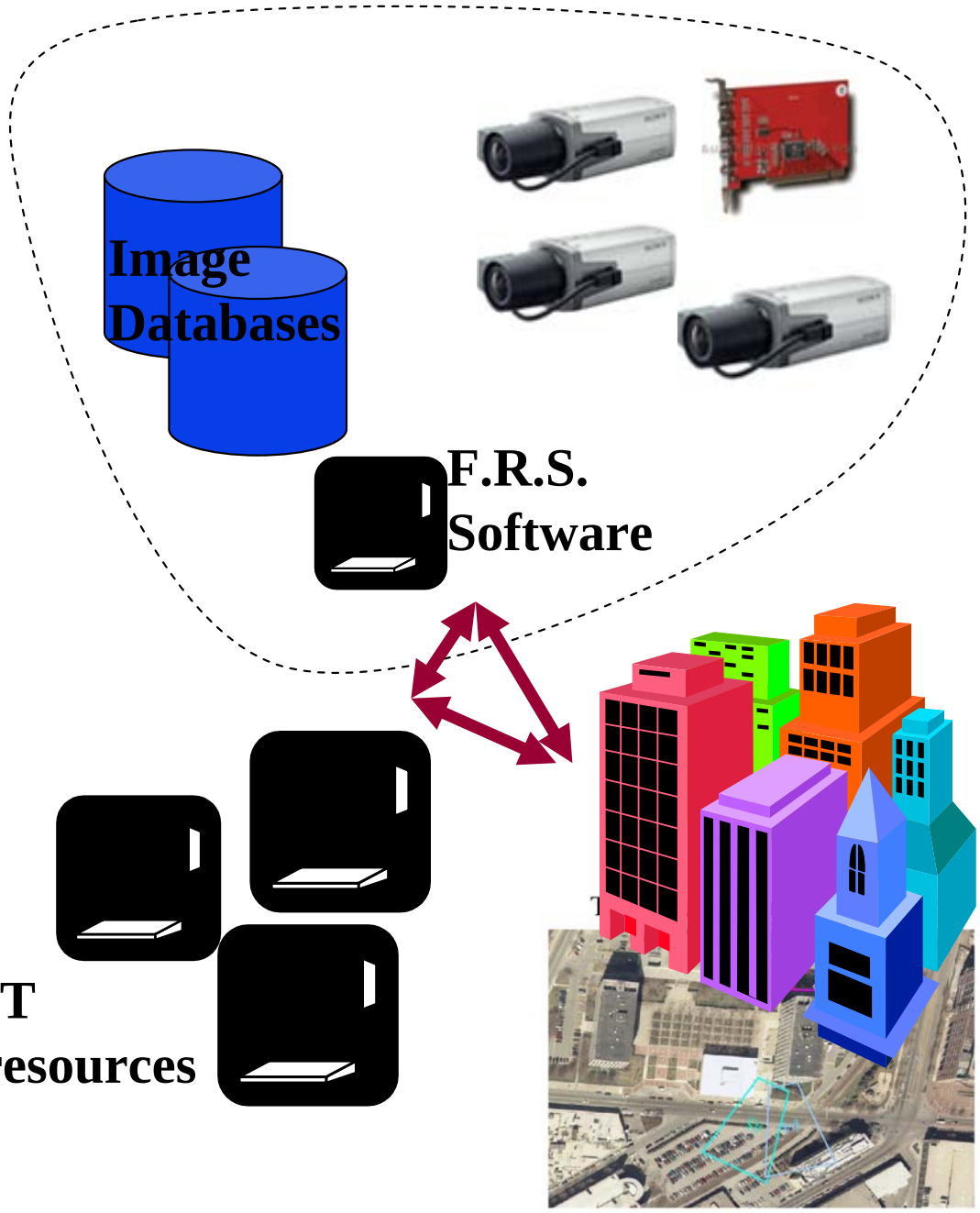
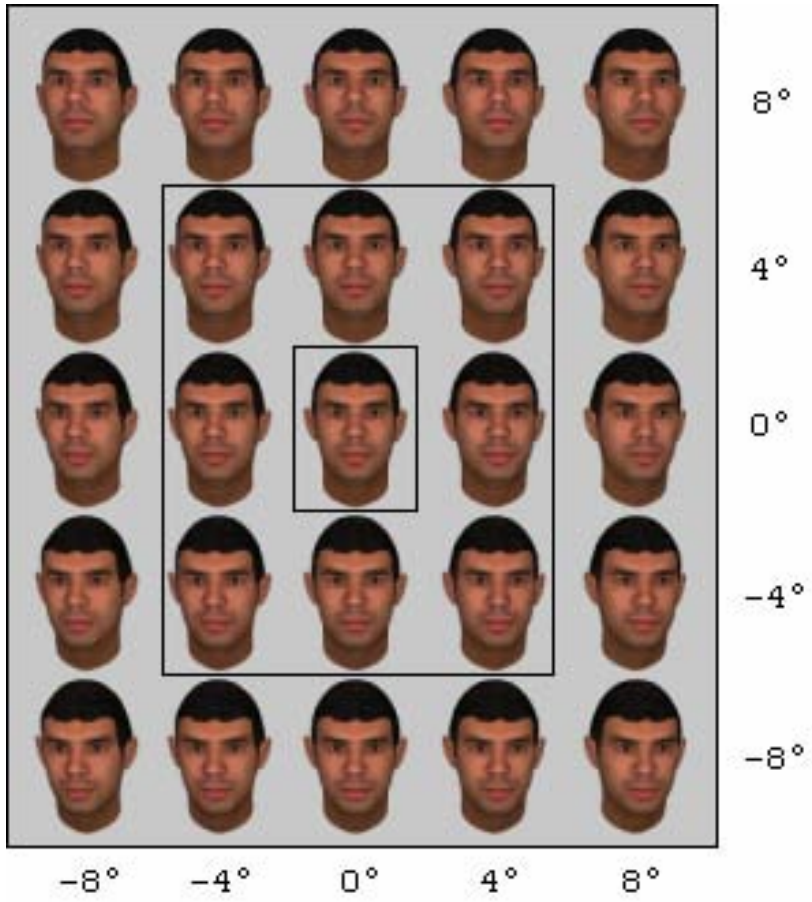
Highlight (taxonomy)

- **Illustrative Example: Face Recognition System**
- **Elements of Face Recognition System (f.r.s.):**
  - **Sensors for Image Capture**
    - **E.g., camera(s)**
  - **Software pertinent to sensor functioning**
  - **Software application program**
    - **Contains heuristics/algorithms for face matching**
  - **Database of Images to match**
- **The f.r.s. will be situated in a physical environment**
- **The f.r.s. will likely use infrastructure resources:**
  - **Network resources**
  - **IT resources**



Highlight (face testing)

- Use synthetic imagery to control all variation except what we wish to test
  - Data gathering not practical in real world
- Construct 25 enrollments for each of 100 subjects by varying pose angles
  - Frontal only class
  - Frontal and ± 4° poses
  - Frontal, ± 4°, and ± 8° poses
  - Up to 2,500 enrollments
- Create probe (match and imposter) imagery to exercise system
  - Poses don't coincide with enrollments
  - 14,400 matching probes
  - 14,400 imposter probes (new subjects)
- Evaluate operational use scenarios
  - Watch list template selection
  - Performance impacts, conditions



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Impacts

- **Collaboration & Coordination with related projects**
  - US-Visit (Biometrics, Standards, and MRTDs)
  - Perceptive Assistive Agents
  - DoD Biometrics Management Office (R. White)
  - ITIC Biometrics
- **Papers**
  - (FY03) “Parametrically Controlled Synthetic Imagery Experimentation for Facial Recognition”, FY03
  - (FY03) “Effects of Eye Position on Eigenface-based Face Recognition Scoring”, FY03
  - (FY04) A Systems-Oriented View of Biometrics Capabilities in Monitoring/Security Systems, draft as of Feb 2004
  - (FY04) Improving Face Recognition Watch List Performance with Template Diversity, March 2004
  - (FY04) Survey of Synthetic Biometric (accepted for publication at IC-IA’04)
- **Biometrics Community, Industry and standards**
  - Worked directly with NIST and Aerospace Corp.
  - FR companies (Viisage, others), M1 standards (DHS)

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Future Plans

- **Biometrics Laboratory**
  - Initiate validation of biometrics systems taxonomy (basic machine vision techniques)
  - Extend sensor coverage (add complexity)
  - Relate performance models to systems models
- **Targeted Face Recognition Experimentation**
  - Complete planned experiments, generate additional test data per request
  - Support and technology transfer techniques to interested sponsors
- **Knowledge Management Efforts (continued)**
  - Internal:
    - Biometrics site http://biometrics.mitre.org
    - Biometrics mailing list
    - Initiated Biometrics speaker series
    - Coordination and collaborated with sponsor work
  - External:
    - Three Papers for peer-review or publication

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